

Project-Specific Laboratory Review

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Project-Specific (Lab) Review

- *Introduction – Overview*
- *Establish project-specific Measurement Quality Objectives (MQOs)*
- *Select analytical chemistry laboratories*
- *Case study*
- *Issues and summary*



Introduction

- *Data quality plays an important role in decision making but is often not adequately addressed in project planning or for decision making.*
- *Present a simple procedure for establishing the minimum project-specific MQOs on Data Quality Indicators (DQIs) precision, bias, and sensitivity based on project Data Quality Objectives (DQOs).*
- *Perform “Project-Specific Review” to select the appropriate DoD ELAP accredited laboratory based on the project-specific DQIs.*



Overview of DQIs

- **Precision:** *Variability; measured by relative percent difference (RPD) of duplicates or standard deviation of LCS recoveries.*
- **Bias:** *Difference between measured and true values; measured by percent recoveries (%Rs) of spikes or mean percent recovery of LCS.*
- **Sensitivity:** *Smallest level for reliably reporting analyte concentrations; measured by the LOD and LOQ.*



How Are MQOs Commonly Established?

- *Copy MQOs from other projects*
- *Use method performance data*
- *Use laboratory performance data*
- *Follow program or regulatory requirements*
- *EPA QA-G/4 DQO process ???*



Common Reasons for Lacking Project-Specific MQOs

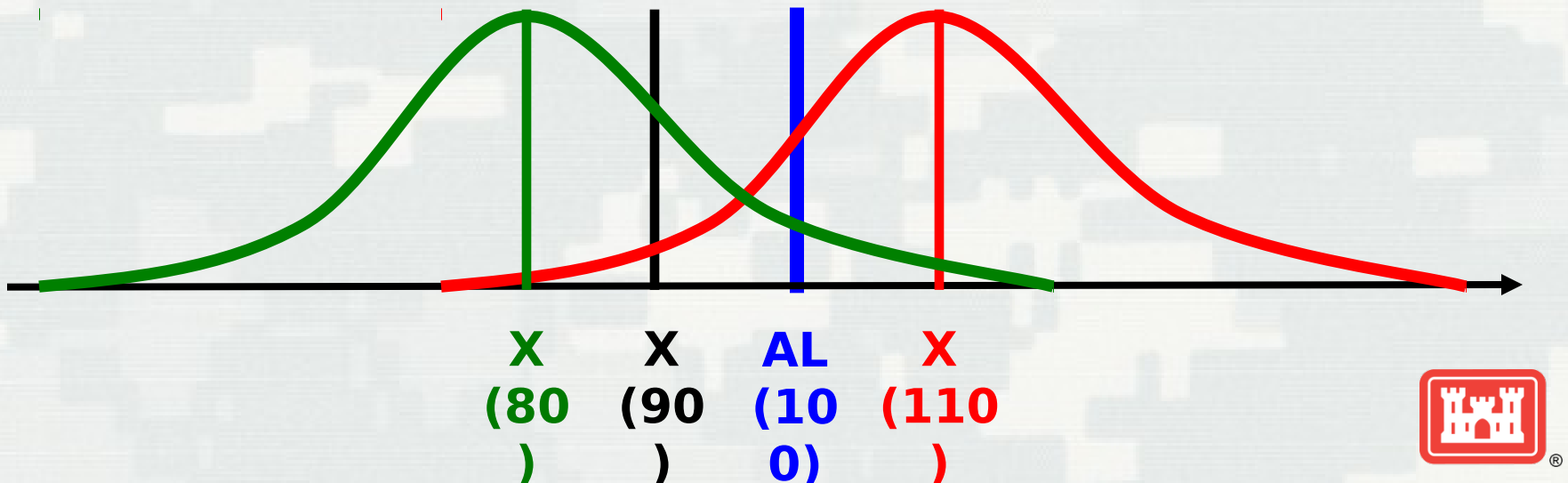
- *Don't know how*
- *Unknown data uncertainty prior to analysis*
- *Huge field sampling errors*
- *Limited resources*
- *No simple, reliable, and cost-effective method*
- *???*



Data Quality & Decision Error

Is a measured [X] of 90 ppb < AL of 100 ppb?

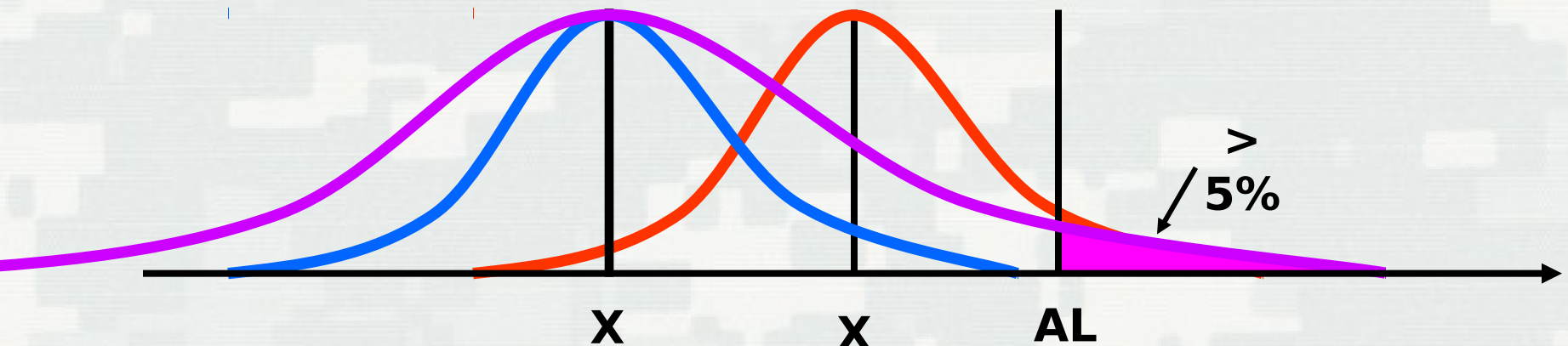
The true [X] could be 80 ppb or 110 ppb and we can't know if a measured [X] < AL!



Data Quality & Decision Error

Will true $[X] <$

~~AL?~~ true $[X] < AL$ @ 95% confidence?



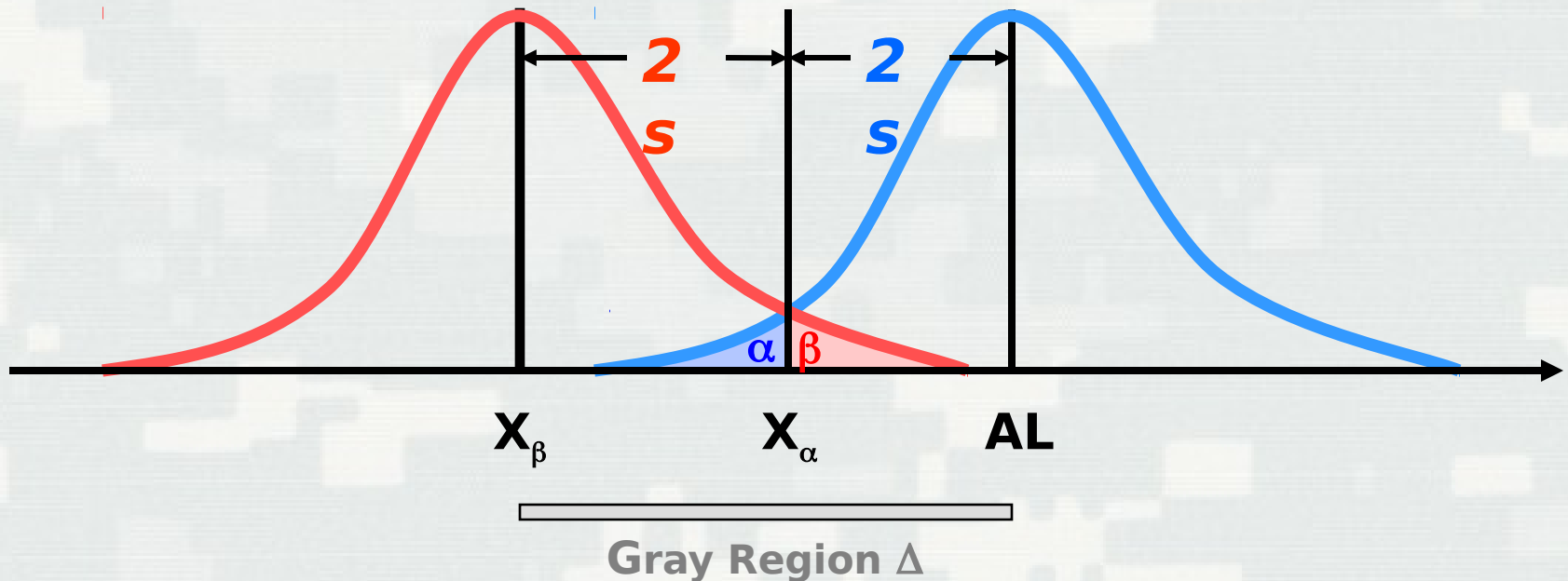
Inputs for Establishing MQOs

- *Minimum project-specific MQOs may be established based on:*
 - ▶ *Action level (AL): Regulatory level, background, risk-based level, etc.*
 - ▶ *Expected data quality: Based on DQOs, method, publication, etc.*
 - ▶ *Tolerable decision errors: α , β*



Data Quality & Decision Error

$H_0: X > AL$, $H_A: X \leq AL$; decision errors $\alpha = \beta = 0.05$



$X_\beta = AL - \Delta = AL - 4s$, where s = standard deviation.

If $X \leq X_\alpha$, site clean; if $X \leq X_\beta$, $\alpha = \beta \leq 0.05$



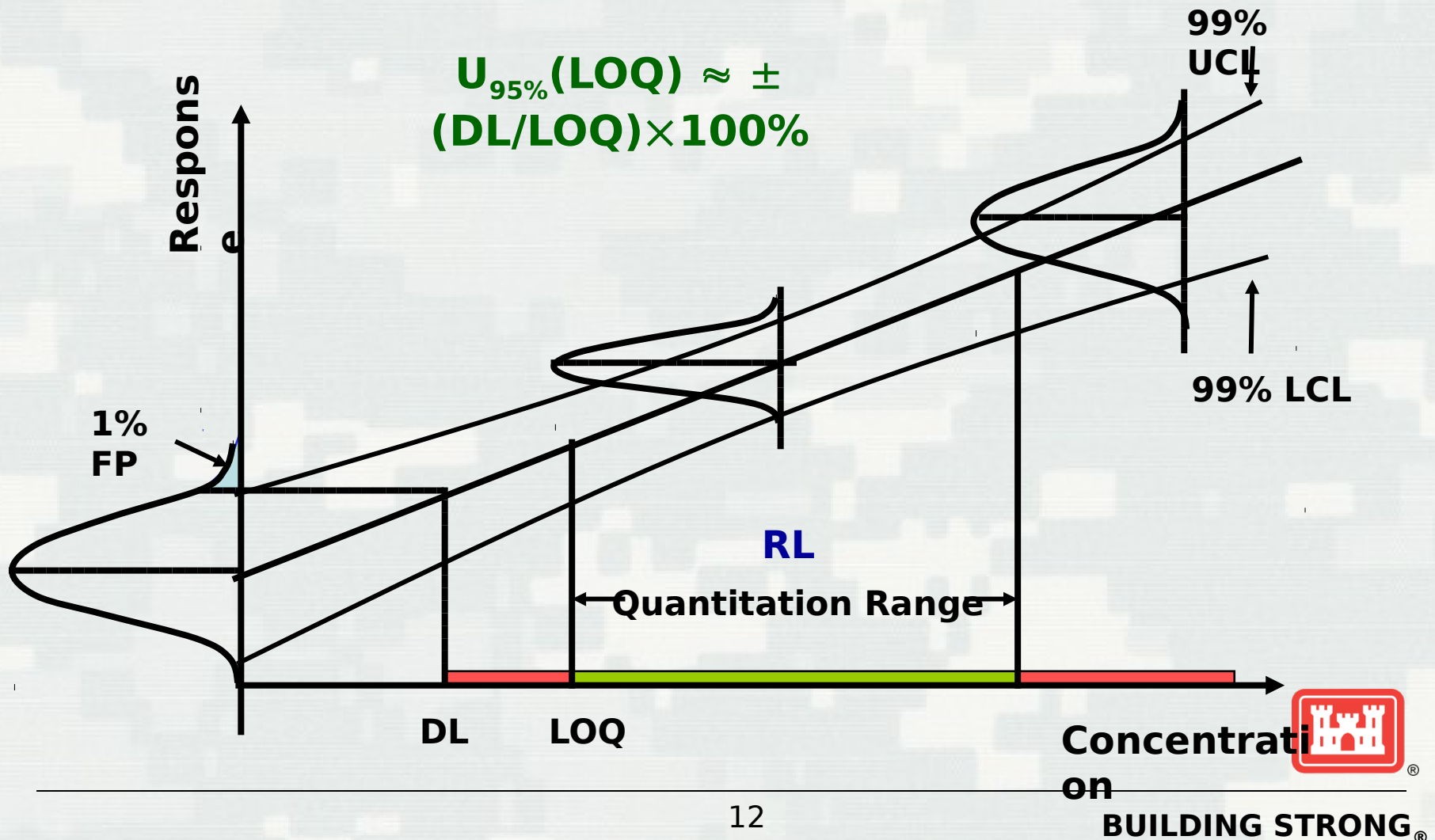
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Definition of RL & LOQ

- **RL:** *Client-specified lowest concentration that meets project requirements for quantitative data with known precision and bias for a specific analyte in a specific matrix.*
– **DoD QSM V4.1**
- **LOQ:** *The minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence.*
– **NELAC Standard, 5 June 2003**
- **LOQ (Clarification):** *The lowest concentration that produces a quantitative result within specified limits of precision and bias.*
– **DoD QSM V4.1**

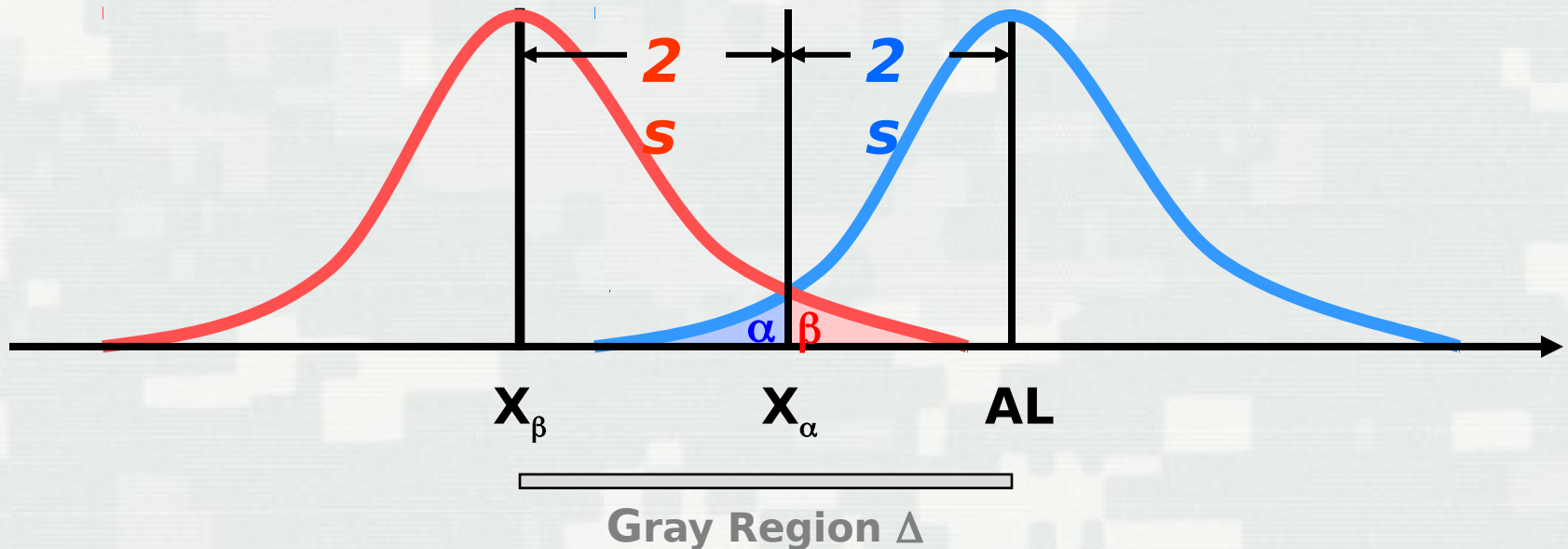


Uncertainty vs Concentration



Project MQOs vs Lab MQIs

$H_0: X > AL$, $H_A: X \leq AL$; decision errors $\alpha = \beta = 0.05$



1. $RL \leq (AL - 4s) \times \%R$ and $s \leq (AL - RL / \%R) / 4 < 25\%$.

~~2. $LOQ \leq RL$ if both have same precision and bias.~~



Example for Establishing MQOs

- *What are the MQOs required for reliable ($\alpha = \beta = 0.05$) disposal of IDW to a landfill if $AL < 50$ ppm?*

- ▶ **Minimum Project MQOs Needed:**

AL: 50 ppm

Tolerable Decision Errors: $\alpha = \beta = 0.05$

Precision: LCS CL = $\pm 30\%$ $\Rightarrow s = 10\% = 5$ ppm

Bias: mean LCS %R = 100% from publications

Reporting Limit: $RL = (AL - 4s) \times \%R = 30$ ppm

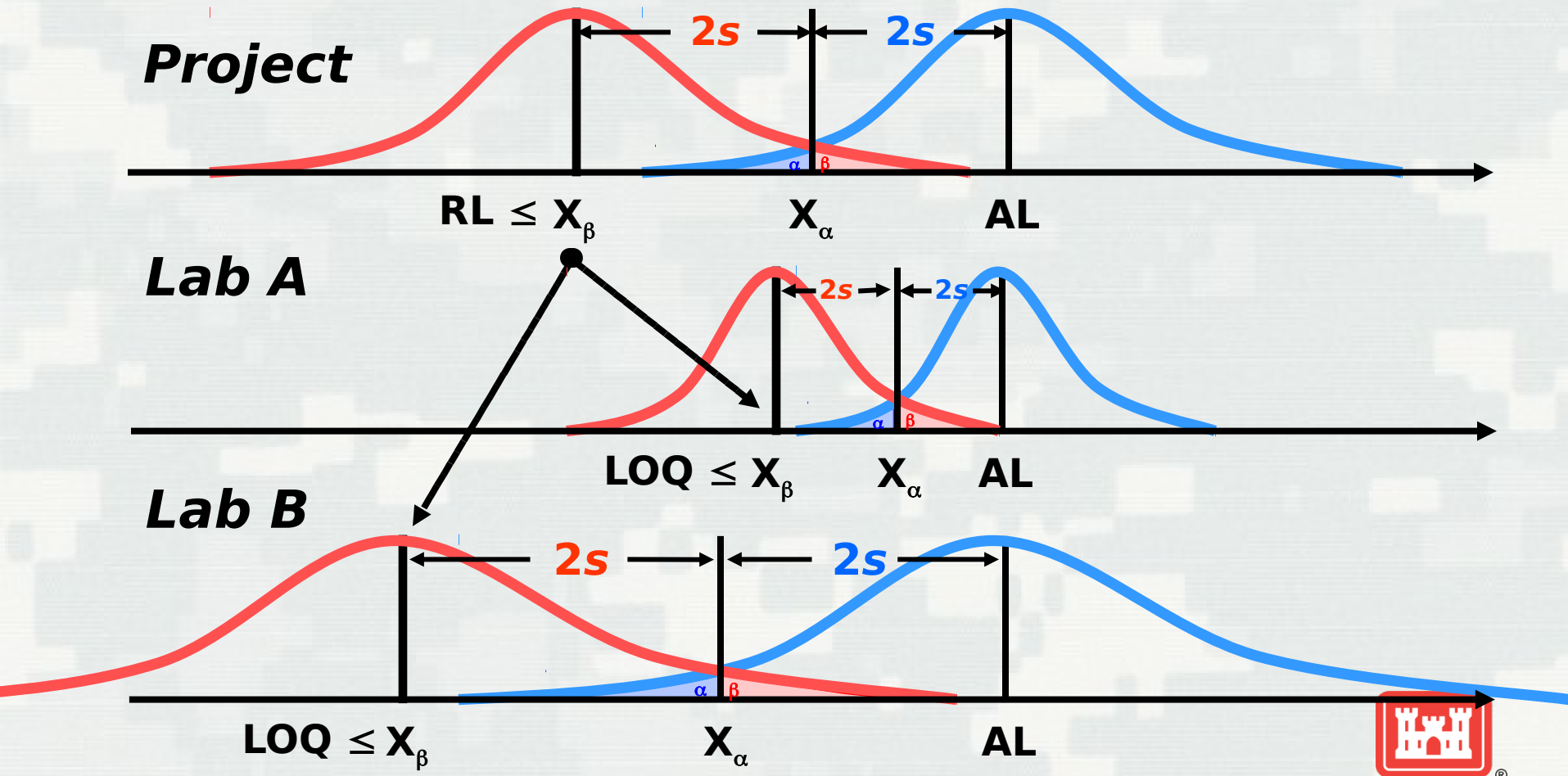
- ▶ **Minimum Laboratory MQIs Needed:**

$LOQ \leq 30$ ppm if precision = $\pm 30\%$ and %R = 100%

$LOQ \leq 15$ ppm if precision = $\pm 30\%$ but %R = 50%



Project RL vs Lab LOQ



Issues

- *Old Rules of Thumb of “LOQ = Lowest Cal. Std. = $3 \times MDL \leq RL \leq 1/5 \sim 1/10 \times AL$ ” may not be adequate.*
- *Laboratory with $LOQ \leq RL$ does not necessarily meet project MQO for sensitivity. Precision & bias must also be considered.*
- *Scientifically valid and consistent procedures are needed for establishing laboratory performance data for precision, bias, and sensitivity.*
- *Total data quality, including field sampling and laboratory analysis, needs to be considered for reliable project planning and decision making.*
- *Laboratory is not liable for compensation of sampling errors. Better sampling design and techniques (e.g., IMS) are needed to reduce field sampling errors.*



Case Study

- Groundwater investigation of a potential source of benzo(a)pyrene contamination. Developing MQOs for precision, bias, and sensitivity & screening contract labs.
 - ▶ AL: MCL = 0.2 ppb; Expected data quality: LCS %R = 81.3% & $s = 9.5\%$ from DoD QSM V4.1; Decision errors: $\alpha = \beta = 0.05$
 - ▶ $RL \leq (AL - 4s) \times \%R = 0.10$ ppb if %R $\geq 81\%$ & $s \leq 9.5\%$
- DoD ELAP Accredited **Lab X**:
 - ▶ SW 8270: LOQ = 0.2 ppb; LCS %R = 82.5% & $s = 16\%$ 
 - ▶ $LOQ \leq (AL - 4s) \times \%R = (0.2 - 4 \times 16.2\% \times 0.2) \times 82.5\% = 0.058$ ppb
- DoD ELAP Accredited **Lab Y**:
 - ▶ SW 8270: LOQ = 0.2 ppb; LCS %R = 84.5% & $s = 9.8\%$ 
 - ▶ SW 8310: LOQ = 0.1 ppb; LCS %R = 92.5% & $s = 9.5\%$ 



Summary

- *Simple, reliable, and cost-effective procedure for establishing MQOs based on project-specific action level, expected laboratory data quality, and tolerable decision errors.*
- *MQOs established based on LCS control limits are minimum data quality requirements. More stringent MQOs are needed to cover sample matrix interferences and field sampling errors.*
- *A useful tool for screening contract laboratories prior to contract award.*
- *$LOQ \leq RL$ may not meet DQOs.*



Overall Review



- *Introduction – Overview*
- *Limit of Detection (LOD)*
- *Limit of Quantitation (LOQ)*
- *Laboratory Control Sample (LCS)*
- *Project Applications*



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Questions?

